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Effect Of Inoculant Rhizobium And Compost As Amelioration On Growth Of Peanut (Arachis Hypogaea) In Soil Post-Coal Mining

Eci Oktaviani, Sudrajat, Dwi Susanto

Abstract: This study aims to determine effect of inoculant Rhizobium and compost on growth and the number of root nodules on peanut in soil media ex-coal minin This research used 2 treatments, which are Rhizobi (0, 10, 15, 20 and 25 g) and compost (0, 100 and 200 g) with 5 replied, respectively. Data obtained were analyzed with Analysis of Variances (ANOVA) followed by Duncan's Multiple Range Test and Kruskall-Wallis (p=0.05). The results showed that the inoculant rhizobium and compost increased the growth of peanut and number of root nodules. The best growth of peanut (Arachis hypogaea) obtained by treatment of inoculant rhizobium 15 g and compost 100 g, and the most root nodules obtained by inoculant rhizobium 25 g and compost 200 g.

Keywords: Soil Post-Coal Mining, Rhizobium Inoculant, Compost, and Arachis hypogaea

1 Introduction

The mining activities can have a negative impact on the environment, not only in the mining process, but also post-mining. Mined lands are generally left open or closed environment issues marked by severe land conditions were very critical and contaminated with toxic materials harmful to living things, and the soils will be seriously affected physically, chemically or biologically. One of them is the toxicity of various types of contaminants, particularly heavy metal compounds that can kill plants, soil organisms and reduced microbial population in the soil [9]. The rehabilitation activities to restore the ecological functions and environmental efforts are needed to improve soil condition is the application of fertilizers, additions and amelioration soil microorganisms. One effective way is used to increase the availability of N in the soil is the provision of rhizobium. Giving rhizobium can help in the process of nitrogen fixation. Selection of legume plants are expected to adaptation to less fertile soil, one crop of beans that are able to adaptation is peanut (Arachis hypogaea). Peanut plants (Arachis hypogaea L.) belongs to the family Leguminosae. Characteristic of the Leguminosae plant is able to form nodules. Nodule is a small bulge in the root portion formed by nitrogen fixing bacteria infection mutualistic symbiosis with legume plants. Nodules capable of N fixation from the air, so that the soil is able to meet most of the needs of the fixation of nitrogen from the results [5]. From the above background, it is necessary to do research on the treatment of Rhizobium and Compost Award to its ability in improving the biological properties of post-mining land and plant growth peanut plants (Arachis hypogaea L.).

- *Eci Oktaviani, Sudrajat, Dwi Susanto*
- *Department of Biology, Faculty of Mathematic and Natural Science, Mulawarman University, Jl. Barong Tongkok No 4 Gn. Kelua, Samarinda, 75119 . East Kalimantan, Indonesia Email: susantodwiki@yahoo.com*

2 Materials and Metods

This study was conducted in May through the month of July 2016 at the Laboratory of Plant Physiology, Faculty of Mathematics and Natural Sciences. Analysis of N levels conducted in the Laboratory of Soil Science, Faculty of Agriculture, Mulawarman University, Samarinda, Indonesia. The materials used in this study is the peanut seed, Rhizobium inoculant be obtained from the Laboratory of Microbiology Faculty of Agriculture Gadjah Mada University, soil post coal mining used was taken in Simpang Pasir village,Samarinda, East Kalimantan, Indonesia, boric acid 1%, H_2SO_4, HCL 0.02 N, Conway indicators, land mines, distilled water and compost.

2.1 Research Design

The design used in this study is completely randomized design with 2 factorial namely Rhizobium inoculant (0, 10, 15, 20 and 25 g) and compost (0, 100 and 200 g)

2.2 Prosedur

Peanut seeds selected with a disability are a uniform size. Peanut seeds soaked in water for 24 hours, the good seeds will sink, bad seeds will float. Good seed is the seed that is ready for treatment. Soil mines to the planting medium is taken at a depth of 0-20 cm. Soil weighed 2 kg and mixed with compost in accordance with a predetermined dose. Then the soil has been mixed incorporated into polybag allowed to stand for 7 days with watered every day. Weighed seeds that will be used later drained beans. Rhizobium evenly mixed with the seeds that have been soaked in water. Rhizobium provided with the prescribed dosage. Seeds that have been inoculated immediately planted in the planting medium. Maintenance done by watering twice a day, every morning and evening. Watering is done based on field capacity with a volume of 500 ml. Plant growth parameters were observed are plant height, number of leaves , wet weight and number of root nodules. The number of nodules effectively calculated for each crop when harvested by cutting way of nodules in a transverse position, effective nodules criteria to identify when the time is split nodules nodules colored reddish - pink.

$$\%\ Effective\ root\ nodules = \frac{The\ number\ of\ nodules\ effectively}{The\ total\ number\ of\ nodules} x\ 100\%$$

2.3 Data analysis

Data were analyzed by analysis of variance (ANOVA) at the stage of 95%. When there is a significant difference between the carrying, conducted by Ducan test with a level of 95%. Data observation wet weight, dry weight and plant relative growth rate (LPR) were analyzed using Duncan test, while data on the number of root nodules, nodule effective, the growth of plants, number of leaves and measured levels of N were analyzed using Kruskal-Wallis and continued by using the Man Whitney with a 95% confidence level.

3 Results and Discussion

3.1 Growth of peanut plants (Arachis hypogaea)

Based on the analysis to a further test of each parameter indicates that the compost and Rhizobium inoculants significantly affect the growth of plant height (P <0.05) (Figure 1).

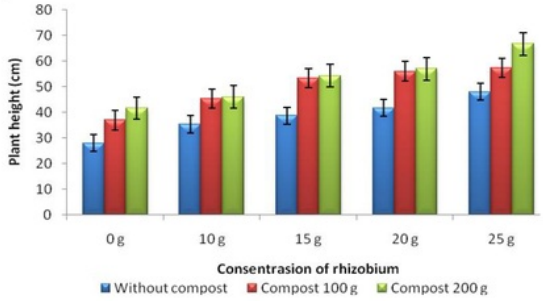

Figure 1. *Effect of Rhizobium inoculant treatment on plant height*

Rhizobium inoculants treatment in the soil without compost were able to increase the average plant height. Higher plants with Rhizobium Award has the highest value at as much as 25 g of Rhizobium significantly different from those without the provision of Rhizobium. Composting as much as 100 g without giving significantly different with compost, but not significantly different from those of 200 g. The highest value obtained by Rhizobium compost 25 g and 200 g. Rhizobium inoculation is very effective if Rhizobium population in the lower realms, so that the necessary dose inoculation appropriate to optimize the function of Rhizobium as a nitrogen pemfiksasi agent. Effect of Rhizobium on plant height as much as 20 g of suspected that a dose sufficient to Rhizobium to fix nitrogen in the air. This is according to research conducted by [12] in which the provision of Rhizobium inoculant enhances growth and legume crop production significantly when compared with the legumes without being given Rhizobium bacteria. For centuries the use of legumes in crop rotation and the use of compost is an important way in the provision of additional nitrogen in the non-legume crops. The increasing growth of plant height from application of compost better and different than without composting to the treatment were able to improve and enhance the availability of nutrients primarily nitrogen and phosphorus are better than the dose without compost, it showed that the compost 100 g of a dose the optimal dose for the alleged availability of N and P in the soil becomes higher and can be absorbed by the bean plants to increase its main growth high higher plants.

Table 1. *Effect of rhizobiuminoculant and compost on the number of leaves*

Rhizobium	Compost			Mean
	K0 (0 g)	K1 (100 g)	K2 (200 g)	
R0 (0 g)	39.33 ± 0.66^{a}	41.33 ± 1.33^{ab}	48.00 ± 0.11^{bc}	42.88^{a}
R1 (10 g)	42.67 ± 1.67^{a}	44.00 ± 4.00^{ab}	46.00 ± 1.15^{bc}	44.22^{ab}
R2 (15 g)	46.00 ± 2.00^{b}	53.33 ± 4.80^{b}	50.00 ± 1.15^{bc}	49.77^{ab}
R3 (20 g)	47.33 ± 0.66^{b}	53.33 ± 4.80^{b}	51.33 ± 4.619^{bc}	5066^{b}
R4 (25 g)	49.33 ± 0.66^{b}	56.00 ± 2.30^{b}	65.33 ± 3.52^{bcd}	56.88^{b}
Mean	44.93^{a}	49.54^{a}	52.13^{a}	

Further test results with the Mann-Whitney shows that the rhizobium inoculants without compost were able to increase the average number of leaves. The average number of leaves in treatment R2 significantly different with treatment R0 (control), whereas treatment R2 to R4 are not significantly different. In soil with compost giving 100 grams (K1) in the treatment R2 has shown a real difference to the treatment R0 (control) (Table 1). This is according to research [13] Legin with compost application shows the influence of the number of leaves. Peanut plants by Legin 10 g on land without compost (K0L2) and the addition of 10 g Legin on land by compost 100 gr (K1L3) and the addition of 20 g of compost Legin 200 g (K2L3) drove ginofor higher than without Legin. According to [4] number of leaves are also influenced by genetic and environmental factors. Added leaves will be in many, if water is available in large quantities in the planting medium.

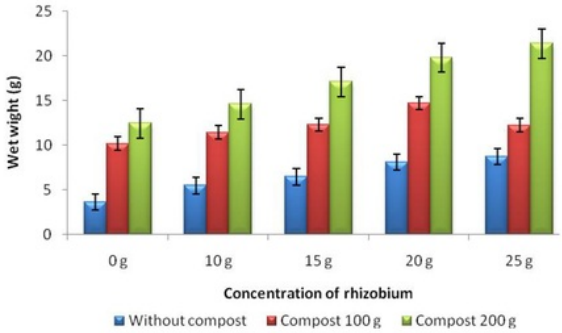

Figure 2. *Effect of Rhizobium inoculant treatment on wet weight*

The test results further by Duncan showed that the rhizobium inoculant without compost can improve wet weight in plants. Value wet weight of 10 g treatment plants at significantly different from that 0 g (control), whereas treatment of 10 gr significantly different with treatment 15 g and 20 g. Similarly, the provision of compost 100 gr significantly different from those of 200 g and without compost (control). Interaction between composting and Rhizobium real effect on the final wet weight at week 8 with the highest value of 21.37 g of the combined treatment of Rhizobium compost as much as 200 g and 25 g while the lowest value in the combination of 10 g of Rhizobium and control treatment (Figure 2). The greater the value of wet weight obtained also the more nutrients are absorbed by the peanut plants. This is presumably because of

fertilizers is increasing will increase the nitrogen content in the soil so that the nitrogen nutrient absorption is increasing as well. According to [10] uptake of nitrogen will result in increasing the nitrogen content in the leaves increased as well. The nitrogen content in the leaf tissue will stimulate an increase in the rate of metabolism of plants. Value wet weight tissue affected by moisture, nutrients and metabolism. This is related to the provision of inoculant Rhizobium are symbiotic with plant legume that fixation of nitrogen in the air which produces N is high, where N can be used by plants to grow and flourish, so that growth will be better and the plants become more severe than without given inoculant Rhizobium , This is in accordance with [8] states that nitrogenya (N) is a constituent of many compounds for plants such as amino acids necessary for the formation of proteins and enzymes. Growth and yield will increase if proteins and enzymes produced more and more, because the proteins and enzymes are raw materials for the formation of new cells that accelerate growth. These results are consistent with the high value crop and plant fresh weight which also showed the highest value at a concentration of 25 g and compost rhizobium 200 g. An increase in height and leaf area followed by an increase in wet weight and dry weight of plants. The higher the dose of fertilizer given the higher plant dry weight. The dry weight of the plant reflects the accumulation of organic compounds synthesized plants from inorganic compounds, especially water and carbon dioxide. Nutrients that have been absorbed by the roots contributed to the addition of the dry weight of the plant. The dry weight of the plant is the efficiency of absorption and utilization of solar radiation available throughout the cropping period by the plant canopy [6] The test results further by Duncan showed that the administration of rhizobium 15 g in 100 g of compost significantly different from those without the granting of Rhizobium (control) but not its real different with rhizobium 25 g. Allegedly giving 15 g rhizobium and compost as much as 100 g is enough to increase the pace optimum plant growth. Interaction between composting and Rhizobium real effect on the growth rate reatif with the highest value of 0,049 g of the combined treatment of Rhizobium compost as much as 100 grams and 15 g. While the lowest value was 0.043g, namely the treatment without composting and without Rhizobium. In interaction composting gave a good response to the relative growth rate of plants, it is due to that mix the soil with a mixture of organic materials to meet the needs for nutrients and nutrients to the plant. Giving Rhizobium not provide a response to the relative growth rate for the treatment of 25 g is not significantly different from the control treatment. The rate of plant growth is affected by the rate asimilai clean and leaf area index. Besih high assimilation rate and optimum leaf area index will increase the relative growth rate of plants Interaction between composting and Rhizobium real effect on the final wet weight at week 8 with the highest value of 21.37 g of the combined treatment of Rhizobium compost as much as 200 g and 25 g while the lowest value in the combination of 10 g of Rhizobium and control treatment. The greater the value of wet weight obtained also the more nutrients are absorbed by the peanut plants. This is presumably because of fertilizers is increasing will increase the nitrogen content in the soil so that the nitrogen nutrient absorption is increasing as well. According to [10] uptake of nitrogen will result in increasing the nitrogen content in the leaves increased as well. The nitrogen content in the leaf tissue will stimulate an increase in the rate of metabolism of plants. Value wet weight tissue affected by moisture, nutrients and metabolism. This is related to the provision of inoculant Rhizobium are symbiotic with plant legume that fixation of nitrogen in the air which produces N is high, where N can be used by plants to grow and flourish, so that growth will be better and the plants become more severe than without given inoculant Rhizobium , This is in accordance with [8] states that nitrogenya (N) is a constituent of many compounds for plants such as amino acids necessary for the formation of proteins and enzymes. Growth and yield will increase if proteins and enzymes produced more and more, because the proteins and enzymes are raw materials for the formation of new cells that accelerate growth.

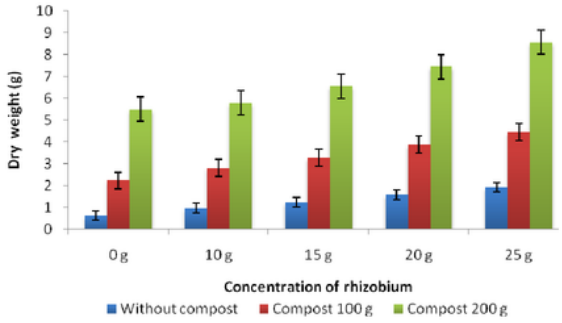

Figure 3. *Effect of Compost treatment on dry weight biomass*

The test results further by Duncan showed that the rhizobium inoculants without compost can improve the dry weight of the plant. The mean dry weight of plants in the treatment of Rhizobium 10 g significantly different from the control treatment, whereas 10 g rhizobium treatment with 15 g and 20 g were statistic significantly. Similarly, the provision of compost 100 grams without giving significantly different with Rhizobium. Interaction between composting and Rhizobium real effect on the final dry weight at week 8 with the highest value of 8.583 grams of the combined treatment of 200 g and Rhizobium compost as much as 25 g and interactions lowest for the control treatment combination that is 0,629 g (Figure 3). These results are consistent with the high value crop and plant fresh weight which also showed the highest value at a concentration of 25 g and compost rhizobium 200 g. An increase in height and leaf area followed by an increase in wet weight and dry weight of plants. The higher the dose of fertilizer given the higher plant dry weight. The dry weight of the plant reflects the accumulation of organic compounds synthesized plants from inorganic compounds, especially water and carbon dioxide. Nutrients that have been absorbed by the roots contributed to the addition of the dry weight of the plant. The dry weight of the plant is the efficiency of absorption and utilization of solar radiation available throughout the cropping period by the plant canopy [6]

Table 2. *Effect of Rhizobium and compost on the relative growth rate of Arachis hypogea.*

Rhizobiom	Compost			Mean
	K0	K1	K2	
R0	0.043 ± 0.00^{ab}	0.043 ± 0.01 ^{abc}	0.460 ± 0.00^{abcd}	0.043 ± 0.01^{a}
R1	0.043 ± 0.00^{abc}	0.046 ± 0.00^{abcde}	0.436 ± 0.00^{abc}	0.044 ± 0.01^{a}
R2	0.044 ± 0.01^{abc}	0.049 ± 0.01 ^{f}	0.426 ± 0.00^{a}	0.045 ± 0.02^{a}
R3	0.045 ± 0.00^{abcd}	0.046 ± 0.01^{abcde}	0.468 ± 0.01^{bcde}	0.046 ± 0.00^{a}
R4	0.045 ± 0.01^{abc}	0.049 ± 0.01 ^{de}	0.474 ± 0.01^{cde}	0.047 ± 0.01^{a}
Mean	0.044 ± 0.00^{a}	0.047 ± 0.01^{a}	0.045 ± 0.01^{a}	

The test results further by Duncan showed that the administration of rhizobium 15 g in 100 g of compost significantly different from those without the granting of Rhizobium (control) but not its real different with rhizobium 25 grams. Allegedly giving 15 g rhizobium and compost as much as 100 g is enough to increase the pace optimum plant growth. Interaction between composting and Rhizobium real effect on the growth rate reatif with the highest value of 0,049 g of the combined treatment of Rhizobium compost as much as 100 grams and 15 g. While the lowest value was 0.043 g, namely the treatment without composting and without Rhizobium (Table 2). In interaction composting gave a good response to the relative growth rate of plants, it is due to that mix the soil with a mixture of organic materials to meet the needs for nutrients and nutrients to the plant. Giving Rhizobium not provide a respon to the relative growth rate for the treatment of 25 g is not significantly different from the control treatment. The rate of plant growth is affected by the rate asimilai clean and leaf area index. Besih high assimilation rate and optimum leaf area index will increase the relative growth rate of plants

3.2 Root nodules, soil and plant tissue nitrogen concentration.

Effect of compost and Rhizobium on the biological properties of the soil after the war with the indicator number of root nodules effectively presented in Table 1 based on tests Kruskal-Wallis against average of nodules effectively plant showed that the compost and Rhizobium on peanut plants affect the nodule effective plant at P <0.05

Table 3. *Effect of Rhizobium and compost to the root nodules of plants (p=0.05)*

Rhizobium	Compost			Mean
	K0(0 g)	K1(100 g)	K3(200 g)	
R0 (0 g)	2.33 ± 0.33^{a}	4.33 ± 0.33^{b}	4.67 ± 1.12^{b}	3.77 ± 0.33^{a}
R1 (10 g)	2.67 ± 0.33^{a}	4.67 ± 0.33^{bc}	6.33 ± 1.13^{c}	4.55 ± 0.33^{b}
R2 (15 g)	3.33 ± 0.33^{ab}	6.00 ± 1.00^{c}	8.67 ± 3.95^{d}	6.00 ± 0.33^{b}
R3 (20 g)	4.33 ± 0.33^{b}	6.33 ± 0.33^{c}	9.33 ± 3.16^{d}	6.66 ± 0.33^{c}
R4 (25 g)	4.67 ± 1.1^{b}	6.67 ± 0.33^{c}	9.67 ± 3.53^{d}	7.00 ± 0.33^{c}
Mean	3.47 ± 0.45^{a}	5.60 ± 0.46^{b}	7.73 ± 0.96^{c}	

Further test results using the Mann-Whitney test showed that, giving Rhizobium soil without compost can improve the effective root nodules on the plant in which the increase in concentration of Rhizobium indicates the number of effective nodules better(Table 3).

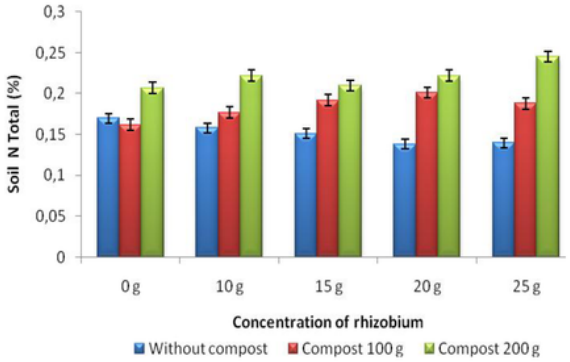

Figure 4. *Effect of compost treatment on soil nitrogen*

Figure 4 showed that the rhizobium inoculants without compost does not show significant improvement, this is shown by the treatment of 20 g rhizobium not significantly different from controls. N Total land to treatment with Rhizobium compost 100 g showed a significant difference among the treatments indicated by the increased value obtained. Composting 200 g and combined with Rhizobium showed the highest value on the total soil N. Interaction between composting and Rhizobium real effect on total soil N with the highest value in the combination treatment of 0.245 g, 200 g and Rhizobium compost as much as 25 g. While the lowest value was 0.170 g which is on treatment without composting and without Rhizobium (control). The more composting is given, the more the content of N in the soil obtained and the better for soil fertility. According to [11] the availability of soil N are more able to produce more proteins, the higher nitrogen applications sooner synthesis of carbohydrates are converted into protein and protoplasm increase plant protein in the body will increase the levels of N in plant tissue.

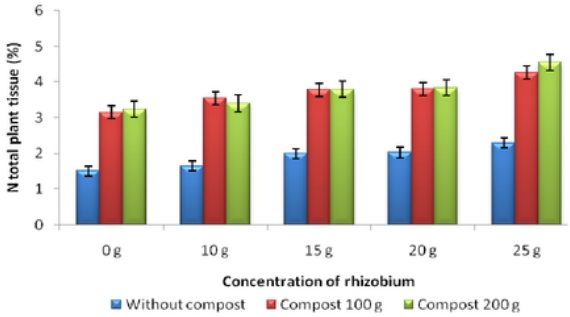

Figure 5. *Effect of Rhizobium inoculant treatment on nitrogen concentration plant tissue*

Figure 5 showed that rhizobium inoculants treatment without compost does not show significant improvement, this is indicated by the higher concentrations of rhizobium given the higher value obtained. Composting as much as 100 g and 200 g show the value that is not significantly different, but it is significantly different from the compost treatment. Interaction

between composting and Rhizobium real effect on total soil N with the highest value of 4.550 g of the combined treatment of 200 g and Rhizobium compost as much as 25 g. While the lowest value was 1.507 g which is on treatment without composting and without Rhizobium (control). From the research results obtained composting as much as 100 g and as many as 15 g of suspected Rhizobium been able to increase the uptake of N in plant tissuesof peanuts. The amount of N uptake in plants thought to be caused by the administration of compost and Legin at the beginning of planting. Increased N total network impact on increasing the rate of photosynthesis and seed yield and increasing the protein content of seeds, increased total N content network on vegetative and reproductive growth phase obtained through N uptake [2].

4 Conclution

Rhizobium inoculant and compost treatment increased of plant height, number of leaves, dry weight biomass, root nodeles, soil nitrogen concentration, nitrogen concentration of plant component and relative growth rate of Arachis hypogea in soil post-coal mining.

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